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# Complications associated with central venous catheters in a haematology unit

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## SUMMARY

*The use of central venous catheters in patients suffering from haematological disorders has brought enormous benefits, but has been associated with an increase in septicaemia. We have reviewed septic and other complications in 43 patients who received one of three different forms of central venous catheters (type A – Hickman®, type B – Portacath®, type C – Pasport®) during 1991. All complications were reviewed up to 18 months following insertion. The total complication rate was 31% (0.97 per 100 catheter days), and the total sepsis complication rate was 18.8% (0.49 per 100 catheter days). Type A catheters had the greatest sepsis complication rate of 29.5% (0.84 per 100 catheter days), with type B 15% (0.39 per 100 catheter days) and type C 9.9% (0.32 per 100 catheter days). Prophylactic antibiotics on the day of catheter insertion did not reduce the sepsis rate or prolong catheter survival.*


## INTRODUCTION

Many of the patients suffering from haematological malignancies benefit from the insertion of indwelling central venous lines as these provide reliable, pain free access for intravenous therapy (chemotherapy, intravenous fluids, blood transfusions etc ), venous sampling and total parenteral nutrition.[1, 2] Three different central venous catheters are inserted in our unit. Type A (Hickman®) lines are hollow silicone-rubber catheters which have central venous access through the internal jugular vein and exit, after a subcutaneous course, through the anterior chest area. Type B (Portacath®) catheters also gain central venous access through the internal jugular vein but, instead of coming out through the skin, end with a subcutaneous reservoir in the lower anterior chest area. This requires to be "plumbed in" using a specially designed needle prior to use. Type C (Pasport®) catheters also have a subcutaneous reservoir but this lies in the forearm and the line gains venous access through the antecubital route. Type A lines are generally inserted for those patients about to embark on intensive chemotherapy, including autologous bone marrow transplantation, while type B and C lines are reserved for those receiving intermittent chemotherapy or rarely in those who are judged incapable of looking after a type A catheter. Patients find these catheters of great benefit and the vast majority master the techniques of long term catheter care in the case of the type A line. Both the

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type B and C catheters have resulted in increasing numbers of patients being able to have chemotherapy at home via a controlled pump infusion. However, use of the catheters has been associated with an increased incidence of septicaemic episodes.[3]

The aim of our study was to evaluate the complication rate (both septic and otherwise ) in the three different central lines inserted in haematology patients during the year of 1991, following all these patients over an 18 month period from the date of insertion.

## PATIENTS AND METHODS

### *Patient Population*

This was a retrospective study reviewing the medical records of all the patients who had Type A, B or C line insertions during the year 1991. The patients were followed for a maximum period of 18 months from the date of line insertion. Forty-three patients had line insertions during the year– their clinical diagnoses are listed in Table 1. There were 21 males and 22 females, mean age 41.7 ± 15.3 years ( 1 SD). It became the policy of the unit to give routine antibiotic prophylaxis to all patients undergoing central catheter insertions in May 1991– this consisted of teicoplanin 200mg iv 2 hours prior to surgery and a further 200mg iv at induction of anaesthesia. The basis for this regime was to attempt to achieve maximal plasma and tissue concentrations of teicoplanin at the time of line insertion. Two groups of patients resulted – those who received antibiotic prophylaxis and those who did not prior to the establishment of this policy.

TABLE 1

*Clinical diagnoses of patients in study.*

| *Diagnosis* | *Number of patients* |
|---|---|
| Acute myeloid leukaemia | 2 |
| Acute lymphatic leukaemia | 6 |
| Hodgkins disease | 3 |
| Non-Hodgkins lymphoma | 9 |
| Multiple myeloma | 19 |
| Plasma cell leukaemia | 1 |
| Synovial cell sarcoma | 1 |
| Myelodysplasia | 1 |
| Osteosarcoma | 1 |

### *Catheter insertion*

There was no formal policy for the type of catheter inserted but, in general, those who were to receive intensive chemotherapy, including autologous marrow transplantation, had a type A catheter inserted. Type C catheters were reserved for those with reasonable venous access in the arms, especially young females where the cosmetic acceptability of this type of line was beneficial. The technique of catheter insertion was not specified by a predetermined protocol but all were inserted by the same surgical team using a strict aseptic technique similar to that described by Heimbach and Ivey.[4] All the patients had general anaesthesia with the exception of 3 patients who had local anaesthesia.

Patients with low platelet counts (<50 x $10^9$/L) were given platelet transfusions before and during the procedure.

Following the procedure wound care was the responsibility of the nursing staff in the ward. Type B and C catheters did not require intensive wound management and clips were generally removed after 7 days. However with type A catheters management involved cleansing of the exit site on a daily basis with chlorhexidine and povidone iodine solutions. The catheter was flushed daily with 10 mls of heparinised saline when the line was not in use. All of the patients were given supervised training by nursing staff with regard to this procedure, and were subsequently able to perform this themselves at home.

*Review of Complications*

Septic and other complications (i.e. thrombosis, extravasation of chemotherapy, malposition of catheter tip, accidental withdrawal and haemorrhage) were reviewed over an 18 month period (maximum) from the date of insertion of the catheter. For this study all septic episodes were classified into three separate categories. 1. Catheter related septicaemia: an episode of microbiologically proven septicaemia in culture from the catheter or peripheral blood, or bacterial growth from the catheter tip. 2. External exit site infection: indicated by either erythema, tenderness, palpable thrombosed vein or pus around the site. This was subsequently confirmed by positive swab culture. 3. Clinically suspicious catheter infection: fever and malaise with no apparent clinical signs of line infection such as erythema or tenderness, no localising signs of other infection and no positive blood cultures, but responding to either teicoplanin or vancomycin.

Cumulative catheter survival was calculated using Kaplan-Meier survival plots, and the log-rank test was used to compare differences in survival between the three lines. Deaths occurring unrelated to line complications, patients with lines in situ at 18 months or with lines electively removed because treatment had finished were "censored" in the analysis. The chi-squared ($\chi^2$) test, with Yates correction, was used to assess for statistical differences between the occurrence of septic episodes in those who had received prophylactic antibiotics and in those who had not.

## RESULTS

Thirteen patients received a type A (Hickman®) catheter, 20 patients a type B (Portacath®) catheter and ten patients a type C (Pasport®) catheter. Four patients received a second type A catheter following removal of the initial catheter and 1 patient required insertion of a second type C catheter following removal of the first, giving a total of 48 catheter insertions. The following results refer to the complications in catheters as opposed to patient numbers. Overall the cumulative catheter survival was 73.1% at six months and 66.9% at both 12 and 18 months. There was a cumulative total of 12,734 catheter days, a total complication rate of 31% or 0.97 per 100 catheter days and a total septic complication rate of 18.8% or 0.49 per 100 catheter days. There were no statistically significant differences in the cumulative survival of the three different lines up to six months or between type B and C catheters up to 18 months (log rank test). Results for the individual catheters are summarised in Table 2.

TABLE 2

*Summary of results for three different lines.*

| | *Type A* | *Type B* | *Type C* |
|---|---|---|---|
| Number inserted | 17 | 20 | 11 |
| Cumulative total days | 2757 | 6857 | 3120 |
| Complication free | 10 (59%) | 15 (75%) | 8 (73%) |
| Sepsis complication | 5 (29.5%) | 3 (15%) | 1 (9%) |
| (per 100 catheter days) | 0.84 | 0.39 | 0.32 |
| Non-Sepsis complication | 2 (11.5%) | 2 (10%) | 2 (18%) |
| Cumulative catheter survival | | | |
| 6 months | 63.7% | 78.6% | 79.5% |
| 12 months | — | 78.6% | 66.3% |
| 18 months | — | 78.6% | 66.3% |

With type A catheters, four patients developed catheter related septicaemia, necessitating removal of the lines following failure of antibiotic therapy. These were subsequently replaced and no further complications occurred with the new lines. One other patient had a clinically suspicious catheter infection that responded to teicoplanin. All of the patients suffering from acute leukaemia (n=8) received type A catheters and it was four of these patients who developed the catheter related septicaemia. The other type A catheters were inserted in patients with relapsed non-Hodgkins lymphoma (n=4) and Hodgkins disease (n=1) who required marrow ablative chemotherapy. Three patients died with their lines *in situ* from causes unrelated to catheter sepsis. In the remaining patients catheters were electively removed following treatment, with all of the lines having been removed (or the patient having died) after six months. The only non-septic complications seen were two lines that were accidentally withdrawn.

With type B catheters, three patients developed catheter related septicaemia but all responded to intravenous antibiotics. Eight patients died with their lines *in situ* from causes unrelated to catheter sepsis, the others surviving the 18 month study period. The non-septic complications were one catheter induced subclavian vein thrombosis and one extravasation of chemotherapy.

With type C catheters, there was no catheter related septicaemia, but one episode of exit site infection occurred that responded to antibiotics. Four of the patients died with their lines *in situ* from causes unrelated to catheter sepsis, the others surviving at 18 months. The non-septic complications included one catheter tip lying in the wrong position and another of extravasation of chemotherapy.

Out of a total of 48 catheter insertions, 18 were carried out without prophylactic antibiotic cover (seven type A, seven type B, four type C). There was no statistical difference in cumulative catheter survival between those who had received prophylactic antibiotics (n=30) and those who had not (n=18) [log-rank test, $p>0.5$]. Similarly, there was no statistical difference between the number of septic episodes in the two subgroups, either in the initial four weeks following the insertion (three episodes in the prophylactic antibiotic group as opposed to two in the non-prophylactic group, $\chi^2=0.22$, $p>0.5$) or overall (five episodes compared to four $\chi^2=0.73$, $p>0.25$). Comparison of the individual lines was not possible because of the small numbers involved.

There were seven episodes of catheter related septicaemia caused by *Staphylococcus epidermidis*, one episode of exit site infection caused by *Staphylococcus aureus* and one episode of clinically suspicious line infection. All the episodes of septicaemia secondary to catheter infection were caused by coagulase negative staphylococci and despite treatment with the most effective antibiotics against these organisms (teicoplanin and vancomycin), four of the catheters had to be removed. The one episode of exit site infection related to *Staphylococcus aureus* responded rapidly to appropriate antibiotics.

Non-septic complications accounted for about 50% of the total complications. The one episode of subclavian vein thrombosis required treatment with thrombolytic agents and subsequent removal of the line, with delay in delivering the next course of chemotherapy. The two cases of extravasation probably occurred due to the needle either not being correctly positioned in the subcutaneous reservoir or having slipped out from the reservoir during the infusion. Both these patients were very ill and died within a short period of time from other causes unrelated to the extravasation. The two type A lines that were accidentally withdrawn did not require replacement and the type C catheter, whose tip lay in the internal mammary vein, had to be removed and replaced before treatment could commence.

## DISCUSSION

Central venous catheters have increased in popularity due to the improved quality of life associated with them. Patients suffering from haematological malignancies require frequent venepuncture both to monitor therapy and to administer chemotherapeutic agents. Many of these agents cause phlebitis and there is a high risk of extravasation of cytotoxic agents that may cause considerable discomfort and even tissue necrosis. Because of these factors central venous access is seen almost as an essential step before the patient undergoes treatment. All the catheters are made of silicone rubber which is less thrombogenic than other materials,[5] they can be inserted with relative ease surgically and many agents and substances can be safely given through them.[1] Patients find them acceptable, they are involved in the care of the lines in the ward and at home and their quality of life is improved to a great extent, which is an important factor for many of those whose long term outlook is not good.

The total number of complications at first sight appears to be high but represents only 0.97 complications per 100 catheter days overall. Sepsis is the most common complication (0.49 per 100 catheter days) but there is considerable variation in septic complications with the type of line inserted; the type B and C being considerably lower than the type A catheters. Our results

are reasonably comparable with those reviewed by Press et al[6] and others.[3, 7, 8] The type A catheter is inserted in patients who are more unwell to start with and undergoing intensive chemotherapy. It is also more susceptible to infection because it is exposed externally and requires greater care and attention from the patient. Many of the patients undergoing line insertions are very ill and may have low blood counts. They can develop episodes of pyrexia, on the basis of presumed infection, but blood cultures are often negative and there is no other microbiological proof of sepsis other than response to empirically prescribed antibiotics. The catheter may well be the source of sepsis in some of these cases.

Most instances of catheter infection are caused by coagulase negative *Staphylococcus epidermidis*,[6, 9, 10] with at least half the strains producing an extra-cellular "glue" substance which causes adherence of the organisms to the catheter wall and protects them from the action of antibiotics. Even the most effective antibiotics against these strains are only effectual in up to one third of cases. Once a central line is infected it may well have to be removed as antibiotic treatment alone is not always successful — four out of 8 (50%) in this study. A study by Larson et al[3] reported septicaemia in 38.3% of patients with acute leukaemia who received type A lines and Hickman reports similar figures in marrow transplant patients[11] — these results are similar to our own. There is some evidence that prophylactic antibiotics given at the time of insertion have a role in preventing later catheter related sepsis and in prolonging catheter life.[3, 9, 12] In our study we were unable to demonstrate any difference in cumulative survival or septic complication rates following the introduction of prophylactic teicoplanin but numbers are small and a larger randomised study would be required.

Although sepsis represents the majority of complications seen with these central catheters and is an important cause of morbidity, mortality appears to be very small and indeed, none of the patients died from septicaemia secondary to catheter infection. Other non-septic complications seen include damage to the lines, venous thrombosis and blocking of the catheters. There are thrombolytic agents available (urokinase) to unblock catheters and repair kits are available for the repair of type A catheters.[13] Non-septic complications accounted for about 50% of the total complications overall, and played an increasing role in the lines less susceptible to septic complications. All complications are associated with extra cost to the hospital in terms of additional medical and nursing care, and therefore all possible precautions should be taken to attempt to decrease the occurrence of these episodes. The non-septic complications may be more amenable to prevention than the septic ones. The risk of extravasation of chemotherapeutic agents can be minimized by carefully checking that the needle is lying in the subcutaneous reservoir and subsequently securing this firmly to prevent it from slipping out. Radiological assessment, with the use of radio-contrast dye, can be used if doubt exists and this will also reveal the position of the catheter tip. The risk of accidental withdrawal of type A catheters can be decreased by good patient education and ensuring that the line is well secured.

In conclusion these catheters improve quality of life although septic complications are a significant problem. Fortunately, the vast majority of these episodes can be satisfactorily controlled with antibiotics. Increasing experience in the use of

these catheters, both by patients and by medical/nursing staff, and further improvement in the design and materials used in manufacture may lead to reduction in septic complications in the future. The role of prophylactic antibiotics requires further intensive investigation.

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